A Zero-Gravity Cup for Drinking Beverages in Microgravity

This spill-resistant cup can be used by commuters for general beverage consumption on-the-go.

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To date, the method for astronauts to drink liquids in microgravity or weightless environments is to suck the liquid from a bag or pouch through a straw. A new beverage cup works in microgravity and allows astronauts to drink liquids from a cup in a manner consistent with that on Earth.

The cup is capable of holding beverages with an angled channel running along the wall from the bottom to the lip. In microgravity, a beverage is placed into the cup using the galley dispenser. The angled channel acts as an open passage that contains only two sides where capillary forces move the liquid along the channel until it reaches the top lip where the forces reach an equilibrium and the flow stops. When one sips the liquid at the lip of the channel, the capillary force equilibrium is upset and more liquid flows to the lip from the reservoir at the bottom to re-establish the equilibrium. This sipping process can continue until the total liquid contents of the cup is consumed, leaving only a few residual drops — about the same quantity as in a ceramic cup when it is drunk dry on Earth.

The free surface profile, governed by surface tension forces, was sufficient to keep the water from spilling during normal cup motions, thus allowing for the cup to be moved about like one would normally do for drinking beverages during a meal. Unlike on Earth, the cup could not be set on a table, but it could be parked on a wall and when desired, picked "up" for a sip.

Figure 1. **Astronaut Don Pettit Moves the 0 G Cup** about the cabin without spillage while Steve Bowen takes a sip of tea.

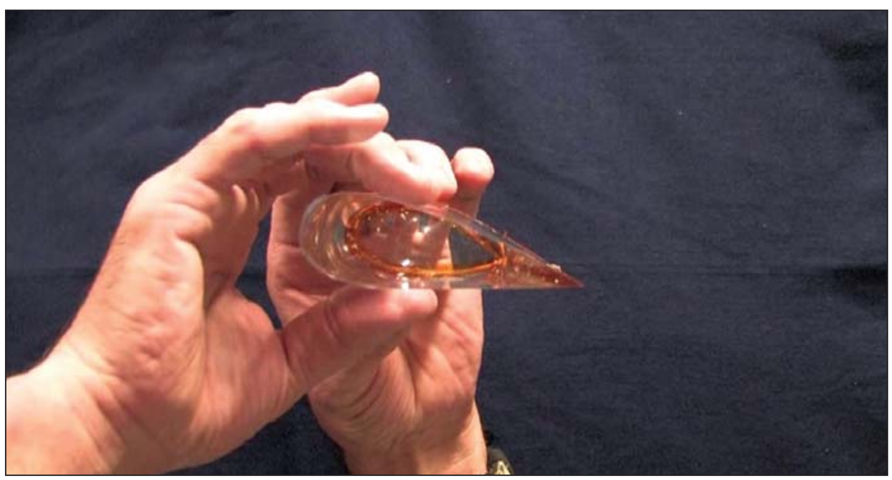

Figure 2. **Top View of the 0 G Cup** showing the cup profile and the liquid channel at the rim.

Flexible walls functioning as a default handle proved to be a highly desirable feature. After the prototype cup was used with coffee where the remaining few drops were allowed to dry, the coffee residue as a contaminant altered the contact angle properties such that when refilled, the coffee was reluctant to move up the channel. A few gentle squeezes of the channel, reducing the angle to a value near zero degrees, increased the effect of capillary motion and quickly moved the coffee to the lip where thereafter the squeezing was unnecessary and the coffee could be sipped normally. As the cup begins to empty, again, gently squeezing the channel walls together, decreasing the angle to a near zero value, helps move the last few drops to the lip. Having a flexible channel is thus useful in initially priming of the fluid if the walls are contaminated from a prior use and in drinking the last few drops.

The main body of the cup could be made from a material optimized for overall cup design, with a specialized coating applied to the inside region of the channel. An example would be a stainless steel cup with an enamel or ceramic coating applied to the inside of the channel. Such a coating could have low contact angles, those closer to glass than metal or plastic, and not pose a breakage safety hazard.

This work was done by Donald R. Pettit of Johnson Space Center, Mark Weislogel of Portland State University, and Paul Concus and Robert Finn, independent consultants. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

This is the invention of a NASA employee, and a patent application has been filed. Inquiries concerning license for its commercial development may be addressed to the inventor:

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